

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Annotated bibliography of coal in the Caribbean Region

by

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This report is preliminary and has not been reviewed for conformity
with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

1/ U.S. Geological Survey, Reston, VA 22092

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ANNOTATED BIBLIOGRAPHY
OF
COAL IN THE CARIBBEAN REGION
by

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U. S. Geological Survey

INTRODUCTION

The purpose of preparing this annotated bibliography was to compile information on coal localities for the Caribbean region used for preparation of a coal map of the region (fig. 1). Also, it serves as a brief reference list of publications for future coal studies in the Caribbean region. It is in no way an exhaustive study or complete listing of coal literature for the Caribbean. All the material was gathered from published literature with the exception of information from Cuba which was supplied from a study by Gordon Wood of the U. S. Geological Survey, Branch of Coal Resources. Following the classification system of the U.S. Geological Survey (Wood and others, 1983) the term coal resources has been used in this report for reference to general estimates of coal quantities even though authors of the material being annotated may have used the term coal reserves in a similar denotation. The literature ranges from 1857 to 1981. The countries listed include Colombia, Mexico, Venezuela, Cuba, the Dominican Republic, Haiti, Jamaica, Puerto Rico, and the countries of Central America.

COAL RESOURCES

Coal in the Caribbean region

Wilgus, C. A., 1959, The Caribbean: natural resources: University of Florida press, p. 132-135.

The countries of the Caribbean region with the largest coal resources are Mexico, Colombia, and Venezuela (fig. 1). The resources in Mexico occur largely in the states of Coahuila and Nuevo Leon in northeastern Mexico. These resources

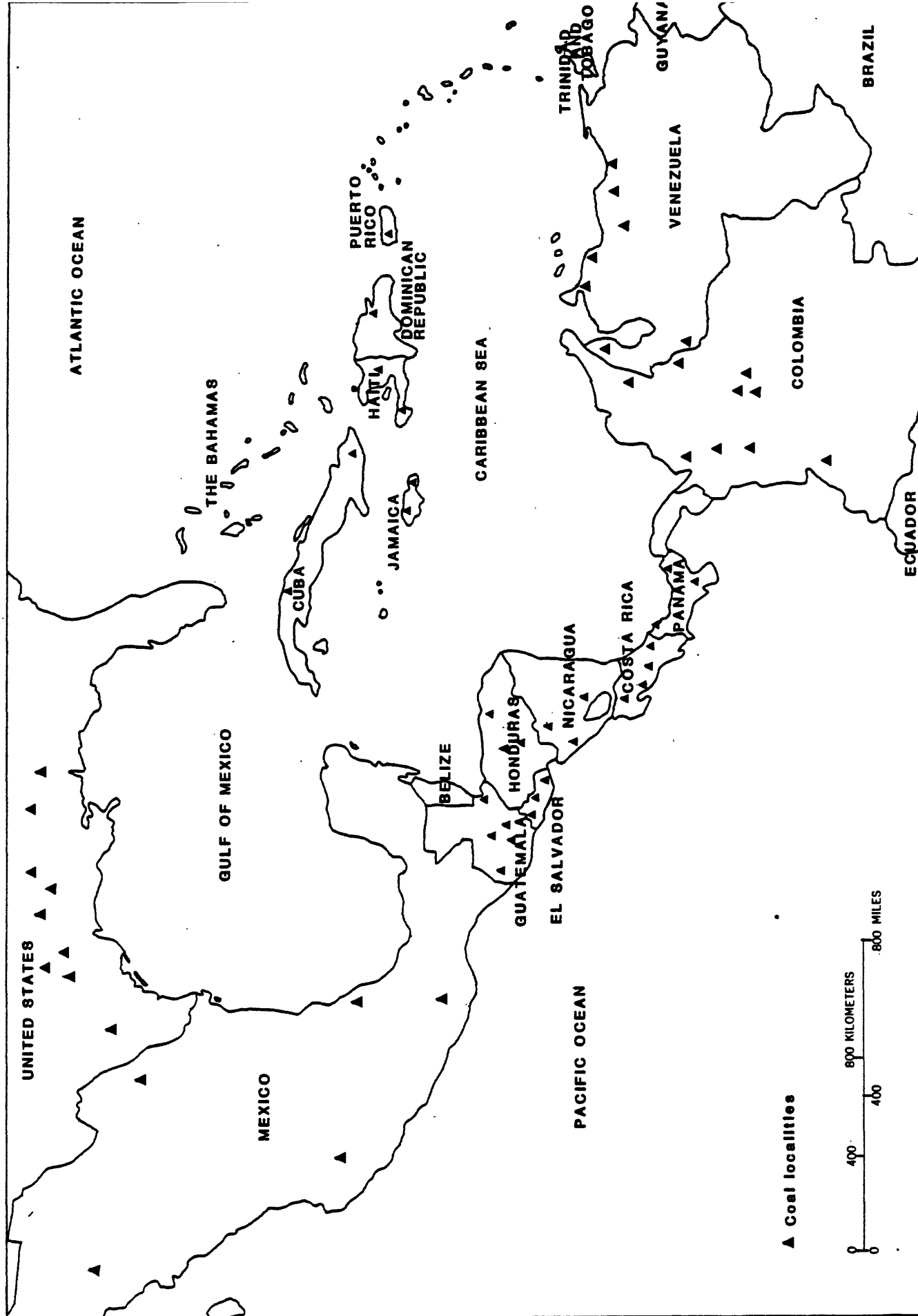


Figure 1. Coal localities in the Caribbean region.

are estimated to be 1,700 million to 3,500 million tons. Coal also occurs in the Oaxaca region (estimated at 100 million tons) and the Yaquia district of Sonora (anthracite estimated at 30 million tons). Colombia has between 50 and 75 percent of the coal found in Latin America. Proved resources are estimated at 12 billion tons and potential resources are estimated at 40 billion tons. Paz del Rio, northeast of Bogota, and the Cauca River valley near Cali, are the most explored regions. The largest coal resources in Venezuela are south and west of Lake Maracaibo in the states of Zulia and Tachina. Smaller resources are also in the states of Guarico, Aragua, Falcon, and Anzoatequi.

Coal in Colombia

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 49-55.

Colombia has the most extensive coal deposits in Latin America. It has been estimated that 10 billion metric tons are suitable for development. The rank of the coal ranges from lignite to meta-anthracite and is of Maestrichtian-Paleocene age in the Eastern Cordillera basin (fig. 2), and middle Oligocene age in the Western Cordillera basin. Both the Eastern and Western Cordillera basins are divided into subbasins. In the Eastern Cordillera, the subbasins are Tocaina-Guaduas, Bogota area, Tunja area, Santander, Pamplona-Cucuta-Catatumbo, Jagua de Ibirico, and El Cerrejon. The Tocaina-Guaduas subbasin is 150 km long and 8 km wide. The coal is in the Guaduas Formation. In the Bogota area subbasin the Guadas Formation contains 5 coal zones ranging in thickness from 6.92 to 17.71 m. The total resources of this subbasin are estimated at 6,281 million metric tons. The Tunja area subbasin is estimated to contain 138 million metric tons of coal in the Guaduas Formation. The coal beds of the Santander subbasin crop out in a 1 km wide zone with a total thickness of 12 m. The Pamplona-Cucuta-Cotatumbo subbasin consists of lignite and bituminous coal in the Carbonera and Los Cuervos

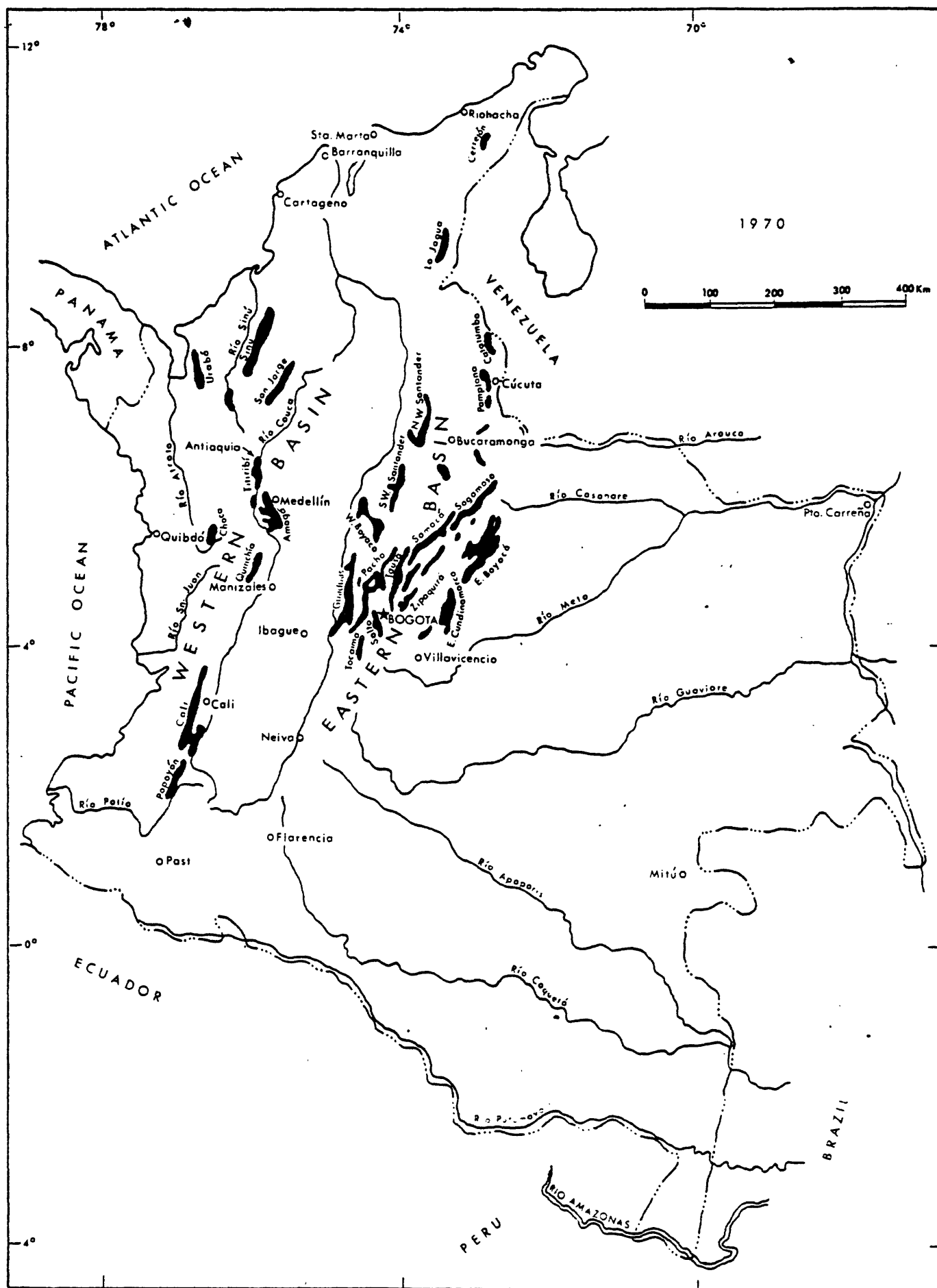


Figure 2. Coal basins of Colombia (from Kottowski, et al, 1978).

Formations. A single coal bed in the Carbonera Formation ranges in thickness from 0.1 to 2.2 m, and the total resources are estimated to be 15 million metric tons. The Las Cuervos Formation has 16 thin coal beds, 5 of which are considered minable. Resources of the Jagua de Ibirico subbasin are estimated to be 100 million metric tons of Paleocene-Eocene bituminous coal in beds up to 5 m thick. The El Cerrejon subbasin has 22 beds of coal interbedded in shale and sandstone. The coal ranges in rank from lignite to bituminous with minable beds ranging from 2 to 10 m thick. Measured resources are estimated to be 32 million metric tons and indicated resources to be 312 million metric tons. The subbasins of the Western Cordillera basin are the Popayan-Cali and the Atioquia. The Popayan-Cali subbasin has Cenozoic (Oligocene?) coal deposits interbedded with claystone and sandstone. Igneous intrusions have altered some of the coal beds to anthracite. The coal beds of the Atioquia subbasin are in Miocene-Oligocene strata. The average thickness of the coal beds ranges from 0.75 to 2.85 m with minable beds up to 10 m thick. The estimated resources are 1,500 million metric tons.

Wilgus, C. A., 1959, The Caribbean: natural resources: Florida University Press, p. 132-135.

Colombia has between 50 and 75 percent of the coal found in Latin America. Proved resources are estimated to be 12 billion tons and potential resources are estimated at 40 billion tons. Paz del Rio (northeast of Bogota) and the Cauca River valley near Cali are the most explored regions.

Coal in Costa Rica

Landis, E. R., and Miller, R. L., 1981, Coal in Costa Rica, a progress report: U.S. Geological Survey Project Report (IR)CS-25.

There are 9 coal or lignite-bearing localities in Costa Rica. They are Upala, Venado, Rio San Carlos, Esparta, Puriscal, El Tablazo, Rio Pacuare, Zent, and

Volio-Cahuita (fig. 3). At Volio, the coal is in the Gatun Formation of Miocene age. The thickness of the coal beds ranges from 0.25 to 1.00 m. Lignite is reported at El Venado, 20 km northeast of Arenal Lake. The lignite is in 2 beds, 2.8 m and 1.25 m thick. Coal is present southwest of the town of Zent, or 27 km west of Limon. Ten kilometers southeast of San Jose at El Tablazo, lignite is in the Coris Formation of early Miocene age. The lignite is in lenticular beds up to 0.8 m thick. Lignite also occurs at Rio San Carlos and Upala in the province of Alajuela. Subbituminous coal is exposed near Barranca at Esparta in the province of Puntarenas. Coal is present at Puriscal in the San Jose province, south of Alajuela, or 20 km west of the city of San Jose. Near the town of Siquirres, Oligocene-Miocene rocks contain coal beds.

Miller, R. L., 1981, Energy resources of Costa Rica: U.S. Geological Survey Project Report (IR)CS-24, p. 6-12.

Coal in Costa Rica ranges in rank from lignite to meta-anthracite. Bituminous coal and anthracite are known in late Paleozoic and Mesozoic rocks. Three areas of coal occurrences are near the Panama border southeast of Limon, north-central Costa Rica in the central highlands belt, and in central Costa Rica near Cartago. At these 3 localities the coal is lignite of Miocene age. A lenticular lignite bed crops out 12 km west of Puerto Viejo. The bed is 0.6 m thick and is in the siltstone-sandstone sequence of the Gatun Formation. Two beds of lignite, 2.8 and 1.25 m thick, are reported in Alajuela Province near Venado. Also, lenticular beds of lignite, as much as 0.8 m thick, are known in a siliceous sandstone in the El Tablazo Hills, 10 km southeast of San Jose.

Coal in Central America

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 65-71.



■ Coal localities

1. Upala
2. Venado
3. Rio San Carlos
4. Esparza
5. Puriscal
6. El Tablazo
7. Rio Pacuare
8. Zent
9. Volio-Cahuita

Figure 3. Coal localities in Costa Rica.

The oldest known coal beds in Central America are in the El Plan Formation of Honduras (fig. 4). These coal beds are of middle Mesozoic age (Triassic-Jurassic) and are interbedded with shale, siltstone, and sandstone. Some of these beds are more than 1 m thick and the resources are estimated at 200,000 metric tons. The coal beds reported in west-central Guatemala near the border of Chiapas State, Mexico, are of slightly younger age than the Honduran coal beds (Jurassic). In Panama and Costa Rica, the upper part of the Gatun Formation of Miocene age contains lignite that is interbedded with argillaceous and sandy sedimentary rocks. A slightly younger lignite-bearing sequence (Miocene-Pliocene), similar to the Gatun Formation, occurs near the Caribbean coast of Guatemala. Local block faulted basins contain lenticular, thin, lignite beds in Honduras, Guatemala, El Salvador, and Nicaragua. The lignite is of probable Pliocene-Pleistocene age, and is considered to have no commercial value.

Coal in Guatemala

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 66-68.

Coal beds of Guatemala range in age from Jurassic through the Cenozoic.

The only known occurrence of a Jurassic age coal bed is near San Jose Ojetenan (fig. 5) in the department of San Marcos. Lignite is in Cretaceous age sedimentary rocks in the departments of Huehuetenango, Quiche, and Alta Verapaz. Lignite beds of Cenozoic age have been identified at Izabal, Cirque Chino, Chino Creek, Livingston, Rio Salado, La Romana, Santo Tomas, Rio Carbonera, Rio Lampera, San Carlos, Rio Santa Elena, and Rio Tameja. A flat-lying lignite bed at Rio Salado, 3 km southwest of Bahia de Amatique, is 0.35 m thick. At Rio Carbonera, 10 to 12 km south of Lake Golfete, 11 lignite beds total a thickness of 8 m. Two lignite beds, 0.30 and 0.35 m thick, crop out 4 km west of Bahia de

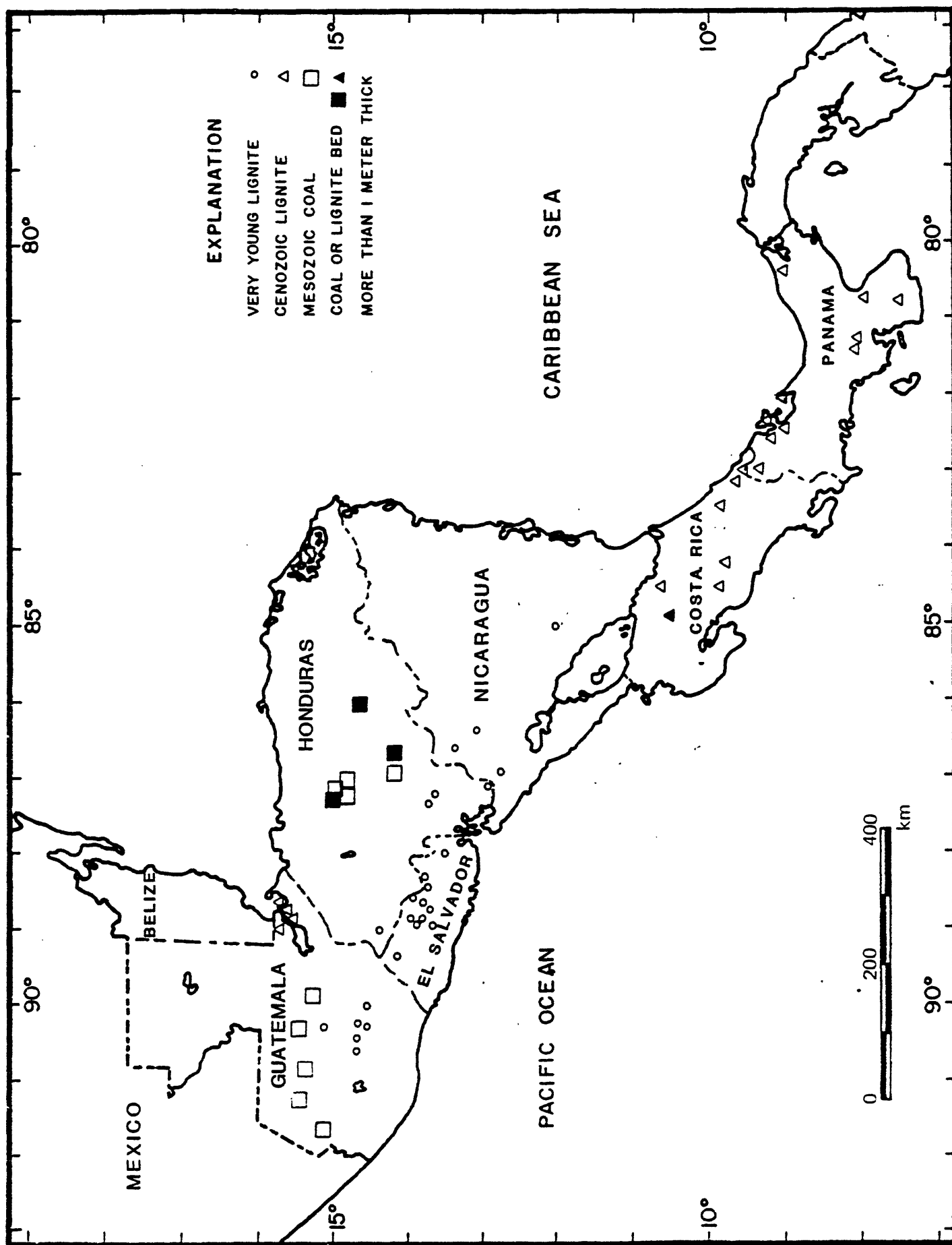
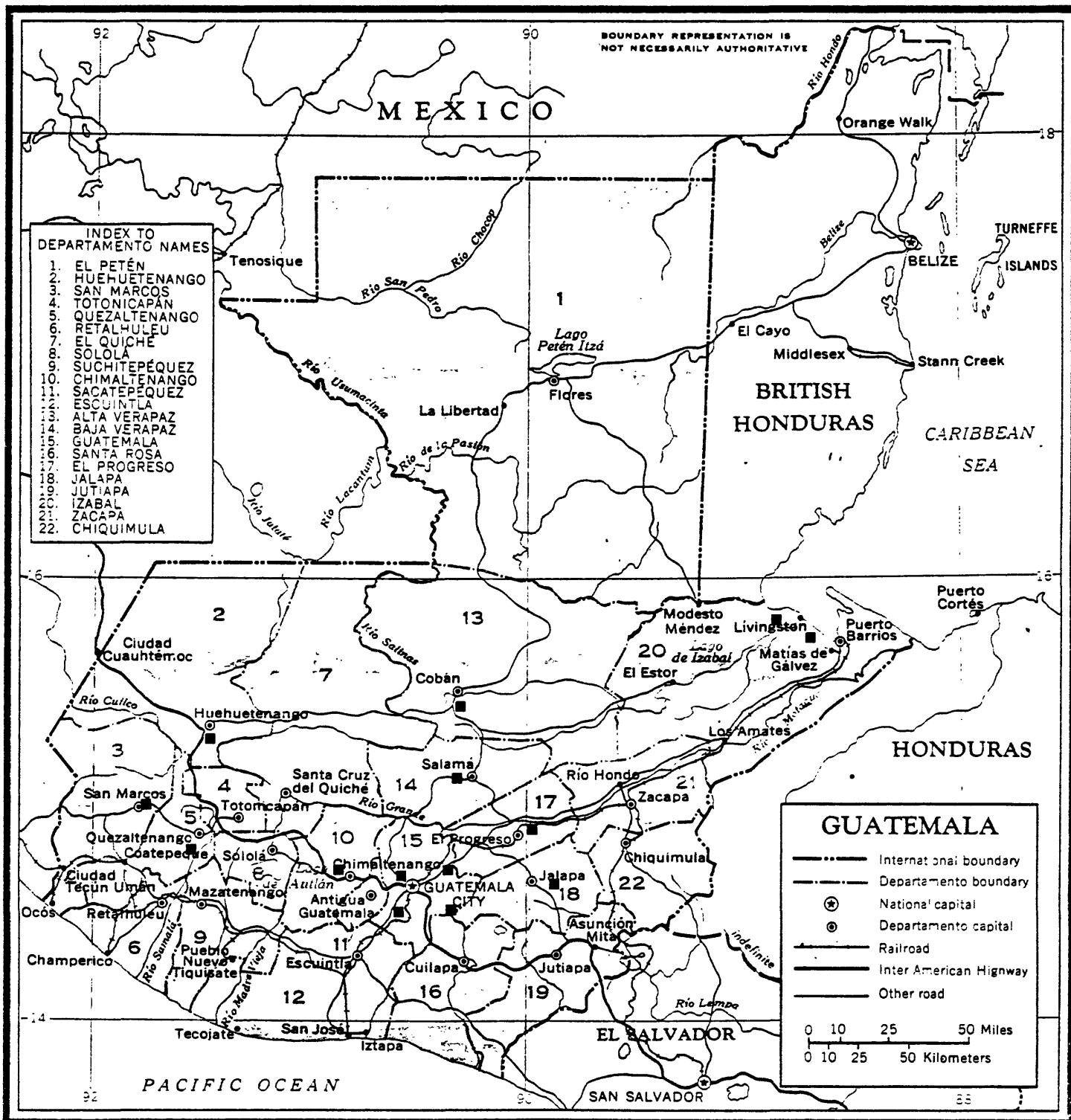


Figure 4. Coal and lignite localities in Central America (from Kottowski, et al, 1978).



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Figure 5. Coal localities in Guatemala.

Amatique, at San Carlos. At Río Santa Elena, four kilometers southwest of Bahía de Amatique, 2 horizontal beds are also 0.3 and 0.35 m thick. In addition, 3 beds of lignite, each 0.1 m thick, are exposed at Río Tameja near Río Dulce.

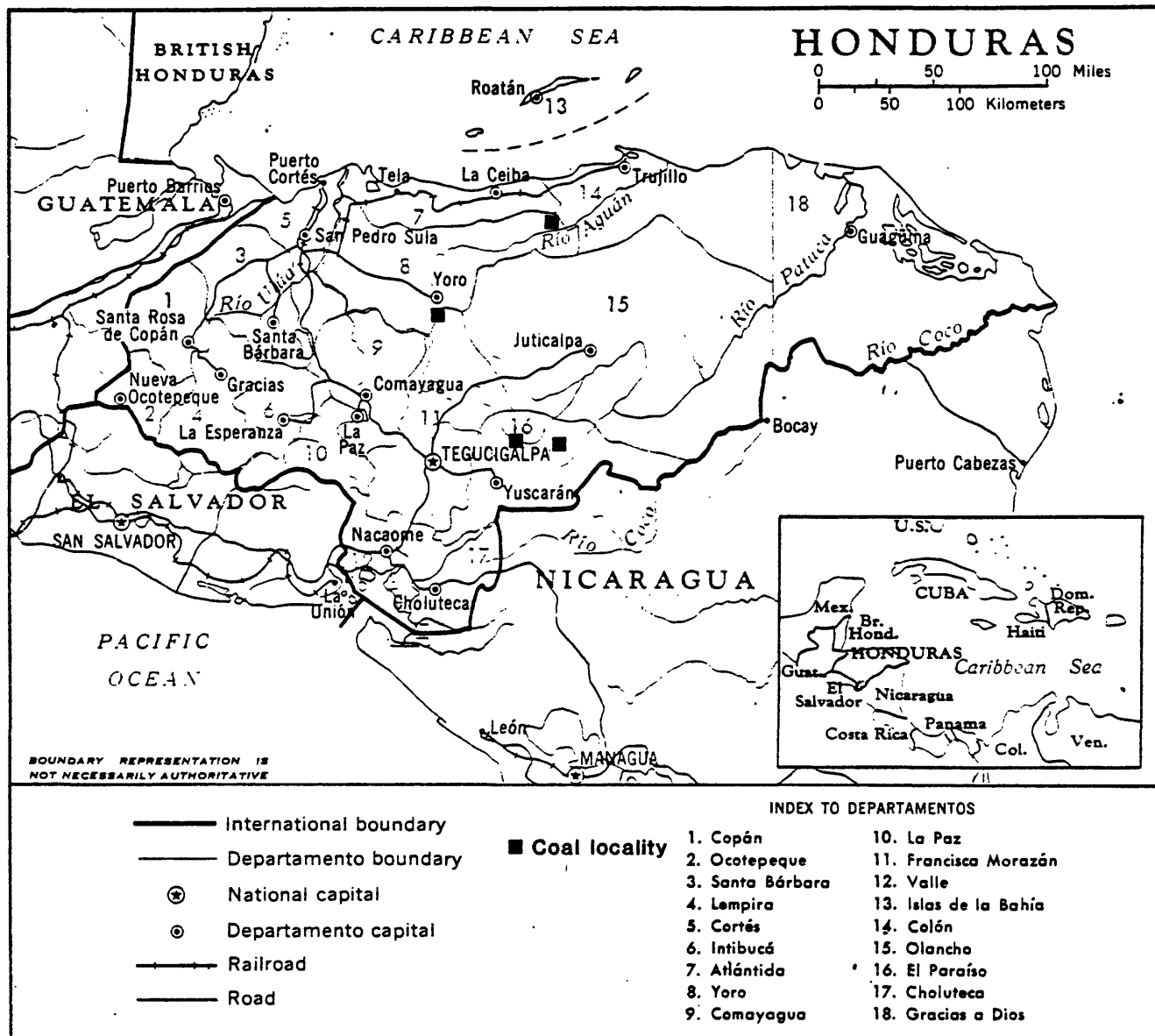
Miller, R. L., 1961, The minerals position of Guatemala in 1961 with special reference to industrial minerals: U.S. Geological Survey Open-File Report, p. 10-21.

Most of the coal beds in Guatemala are of lignite rank; a few are bituminous. The coal beds are usually very thin and local. The thickest seam is in the Lake Izabal area. Coal is known in the departments of Guatemala, El Progreso, Sacatepequez, Chimaltenango, Quezaltenango, San Marcos, Huehuetenango, El Quiché, Baja Verapaz, Alta Verapaz, Izabal, and Jalapa. A thorough investigation of the coal resources of Guatemala is needed.

Coal in Honduras

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 66-69.

Coal beds in Honduras range in age from Mesozoic to latest Cenozoic. Mesozoic coal beds are known in the departments of Yoro, Olancho, El Paraíso, and Francisco Morazan. In the department of Yoro, 5 coal beds each about 0.5 m thick, have been identified in a shale-sandstone sequence at Carbon Creek, east of Chilistagua. South of Catacamas (fig. 6) at Río Frio in Olanche Department, a slate sequence contains 3 beds of coal, 1.8 m, 1.27 m, and 0.9 m thick. Coal beds at El Patoste, 22 km north of Danle in the department of El Paraíso, range in thickness from 2 to 5 m. On the southeast slope of El Chile Mountain, north of Moroceli, in the department of Francisco Morazan, 6 coal beds as much as 2.5 m thick have been identified. Also in the same department, a lignite bed ranging from 0.15 to 0.60 m thick is interbedded with shale and sandstone in the Los Hozcones area, and 2 coal beds of 0.10 and 0.30 m thick are in a sandstone sequence 10 km northeast of El



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Figure 6. Coal localities in Honduras.

Porvenir. Coal beds of Mesozoic age are also reported at Cerro Potrerillos, 9 km east of El Porvenir. Four departments report lignite beds of latest Tertiary age. In the department of Francisco Morazan, lignite is reported at Sabana Grande as a bed 1.8 m thick in siliceous shale that is unconformably overlain by volcanic rocks. Shaly lignite is exposed at Curaren, 10 km east of Aranecina in the department of Valle. Lignite beds also are identified at Las Flores in the department of Yoro, and in the Sensenti Valley in the department of Ocotepeque.

Wells, W. V., 1857, Explorations and adventures in Honduras: Harper Brothers Publishing, New York, p. 539.

Coal is found in the western part of Honduras and on the Pacific coast near the Bay of Fonseca. Mines exist in the departments of Comayagua and Choluteca.

Coal in Mexico

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 58-59, 73-84.

Coal has been reported in 22 of the 29 states, but only 3 states have been well explored. The 3 are Coahuila in the northeast, Sonora in the northwest, and Oaxaca in the south-southwest (fig. 7). Most coal beds are of Cretaceous age, however, coal beds in Oaxaca and Sonora are Triassic and Jurassic in age, and coal beds in Nuevo Leon and Tamaulipas are Tertiary in age. Mexican coal beds range from lignite to anthracite in rank. The coal beds of Coahuila are bituminous in rank, Upper Cretaceous in age, and range from a few centimeters to 5 m in thickness. Resources of the Salinas area in Coahuila are estimated at 1,781 million metric tons and potential resources are estimated at 1,180 million metric tons. Resources of the Rio Excondo basin in Coahuila are estimated at 120 million metric tons. Igneous intrusions have metamorphosed many coal beds in Oaxaca and Sonora, the latter has anthracite beds of Upper Triassic age. Estimates of the resources are

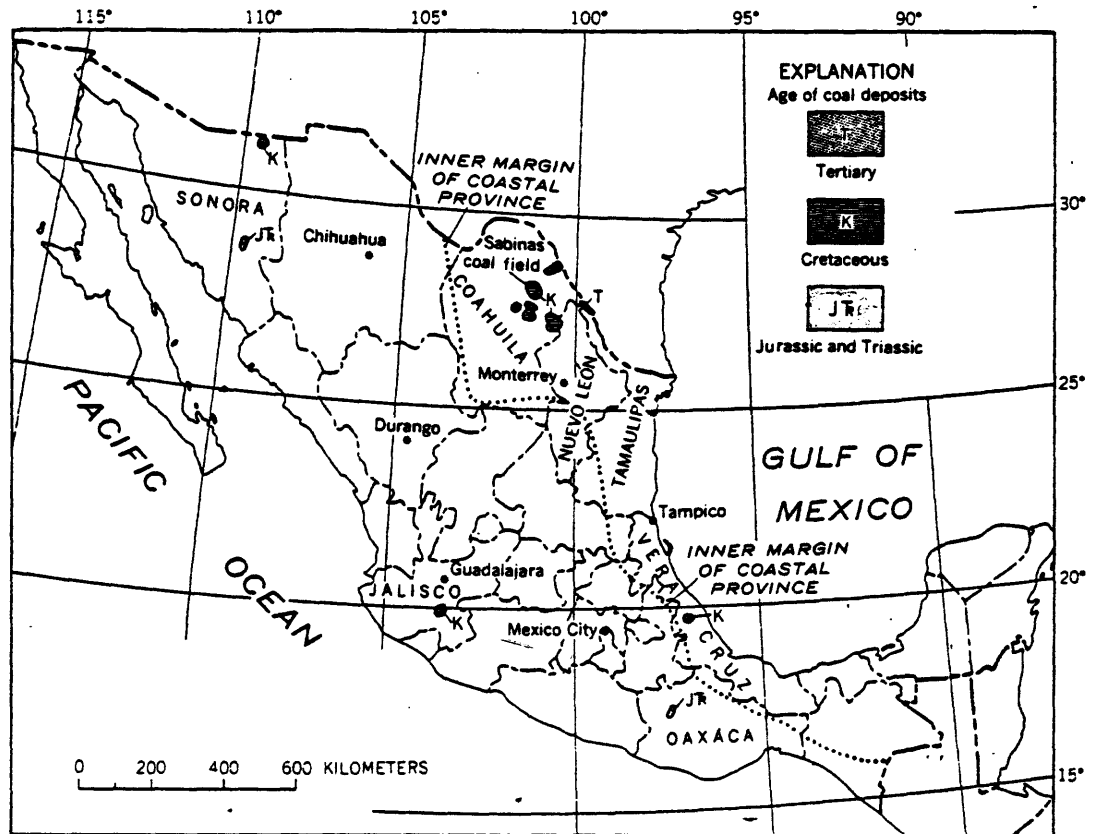


Figure 7. Coal fields of Mexico (from Kotttlowski, et al, 1978).

11 million metric tons in situ, 4 million metric tons measured, 9 million metric tons inferred, and 18 million metric tons possible. Coal beds in Oaxaca are of bituminous and anthracite rank and range in age from lower to middle Jurassic. The resources of Oaxaca are estimated at 24 million metric tons inferred and 26 million metric tons possible.

Wilgus, C. A., 1959, the Caribbean: natural resources: University of Florida Press, p. 132-135.

The coal resources in Mexico are in the states of Coahuila and Nuevo Leon in northeastern Mexico. These resources are estimated to be 1,700 to 3,500 million tons. The Oaxaca region contains an estimated 100 million tons of coal, and the Yaquia district of Sonora an estimated 30 million tons of anthracite.

Coal in Venezuela

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A. 1978, Coal resources of the Americas: GSA Special Paper 179, P. 58-59.

The coals of Venezuela are Eocene-Miocene in age and range from lignite to semianthracite in rank. Total resources are estimated at 1 billion metric tons. At Anzoatequi, 20 beds of coal are more than 1 m thick. Fifteen beds, ranging in thickness from 1.5 to 1.6 m, are known at Zulia (fig. 8). Coal beds 1 to 2 m thick have been identified at Tachina, and 1 m thick-beds are known at Falcon.

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 73-84.

The largest coal resources in Venezuela are south and west of Lake Maracaibo in the states of Zulia and Tachina. The states of Guarico, Aragua, Falcon, and Anzoatequi have smaller resources, none of which have been estimated at this time.

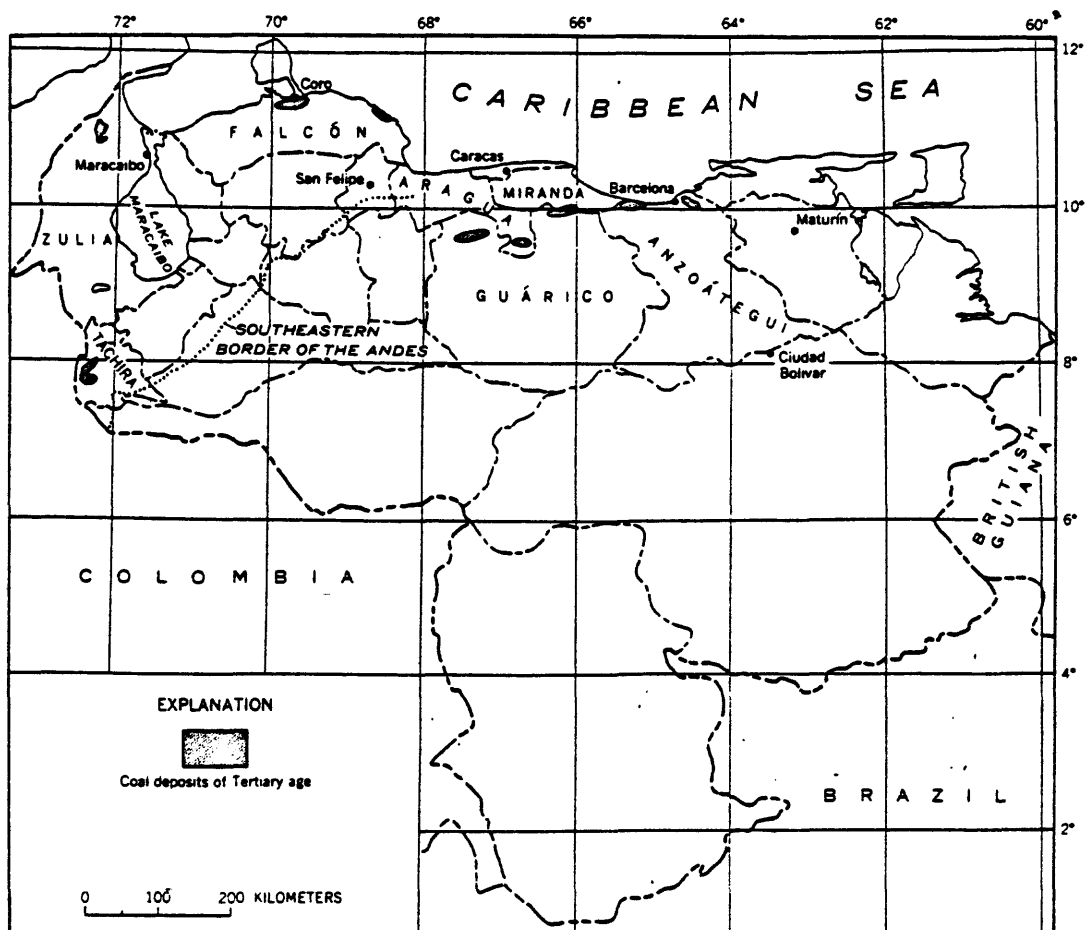


Figure 8. Coal fields of Venezuela (from Kottlowski, et al, 1978).

Lignite in Cuba

An unpublished map and table by Gordon H. Wood (written commun., 1982) shows Tertiary lignite in Cuba at 8 localities. In the eastern part of Cuba, lignite is known at Los Egidos and Fomento, north of Santiago de Cuba, and at Peru, east of Holguin (fig. 9). In the central part of the country, lignite has been identified at Sifio Potrero and Tibiscal, east of Santa Clara; Tuinica, southeast of Santa Clara; Centro, southwest of Santa Clara; and Sierra Morena, northwest of Santa Clara on the northern coast.

Lignite in the Dominican Republic

Vaughn, T. W., Cooke, W., Condit, D. D., Ross, C. P., Woodring, W. P., and Calkins, F. C., 1921, A geological reconnaissance of the Dominican Republic: Geological Survey of the Dominican Republic, Memoirs, vol. 1, p. 244.

Lignite is reported in Tertiary sediments of Miocene age. The lignite is mainly lenses with thicknesses of a few inches. It is sometimes mixed with clay and has little commercial value. The highest quality lignite is near Sanchez on the Samana Peninsula (fig. 10).

Lignite in El Salvador

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 69.

Lignite has been reported in 6 departments in El Salvador. In the department of Santa Ana (fig. 11), lignite crops out near the mouth of Rio Tahuilopa at Rio Lempa. Lignite is known at San Pedro Perulapan, Canton Istagua, Tenancingo, Canton Ajuculco, Suchito, and Canton Tenango in the department of Cuscatlan. In the department of Cabanas, lignite has been identified at Ilobasco, Il Hoyo de Lo Labor, San Isidro, north of Jutiopa, east of Nombre de Jesus, near San Juan Lempa, and near Santa Lucia. Lignite occurrences in the department of San Miguel are at Nuevo Eden de San Juan, west of Carolina, and north of Rio Torola. Coal beds in

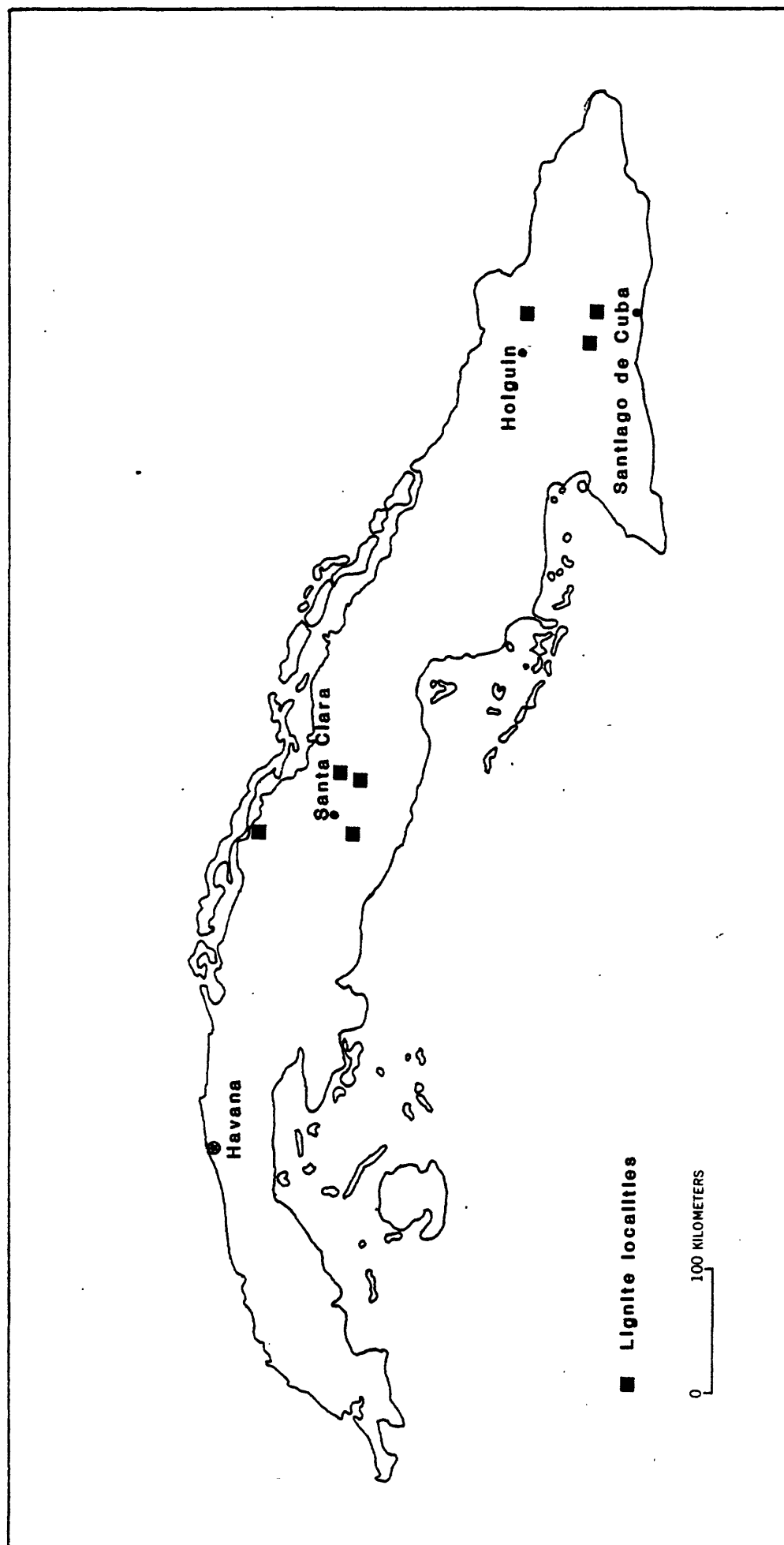


Figure 9. Lignite localities in Cuba.

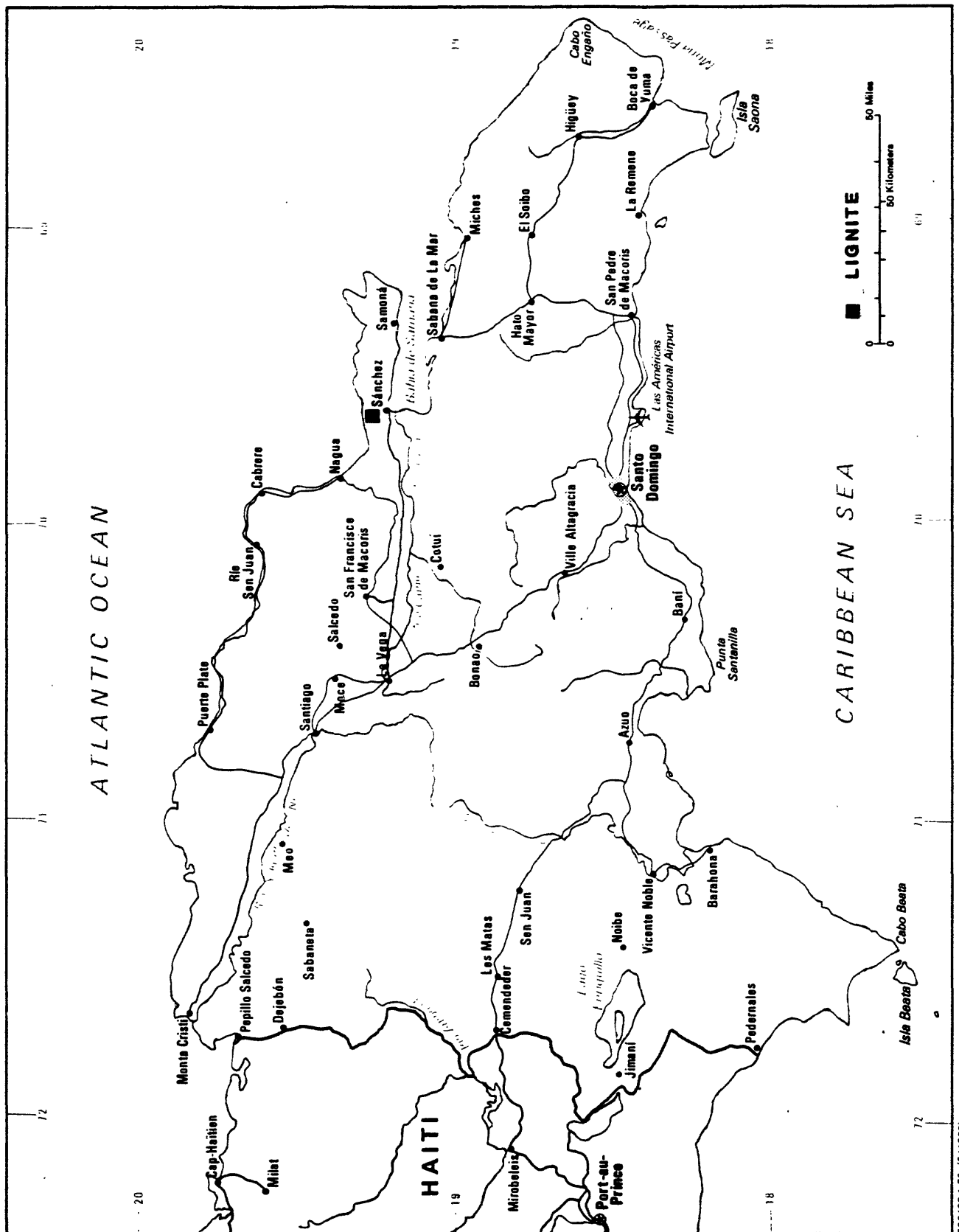


Figure 10. Lignite localities in the Dominican Republic.

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 Lambert Conformal Projection
 Standard parallels 17°20' and 22°40'
 Scale 1:2,000,000

the department of Morazan have been reported at San Simon and north of Yoloaiquin. Lignite has also been identified at El Carmelo and south of Yucuaiquin in the department of La Union.

Lignite in Haiti

Woodring, W. P., Brown, J. S., Burbank, W. S., 1924, Geology of the Republic of Haiti: Republic of Haiti Department of Public Works and Geological Survey of the Republic of Haiti, p. 480-487.

Haiti contains the most extensive deposit of lignite in the West Indies. The largest field is in the northwest central plain near Maissade (fig. 12). There, the lignite is of Miocene age and is interbedded with sandstone, siltstone, and clay of the Thomonde Formation. The lignite beds range in thickness from 0.05 to 1.47 m. Another lignite deposit of Miocene age near Camp Perrin in southwestern Haiti has beds ranging from 0.4 to 2.0 m thick in an area of several square kilometers.

Lignite in Jamaica

Ministry of the Coal Industry of the USSR, 1975, Map of the coalfields of the world: Ministry of Geology of the USSR.

Coal fields in Jamaica are near Port Antonio in the east, and Balaclava and Catadupa in the west (fig. 13). Each area is recorded as having less than 500 million metric tons of lignite in rocks of Paleogene (early Tertiary) age.

Zans, V. A., 1951, Economic geology and mineral resources of Jamaica: Jamaica Geological Survey, Bulletin 1.

Coal (lignite) is contained in Eocene shale, sandstone, and carbonaceous shale (Richmond Beds) in the area east of Mooretown, south of Port Antonio. Lignite beds as much as 4.5 ft thick are exposed in the Yellow Limestone (middle Eocene) between Lichfield and Wait-a-bit, northeast of Balaclava. Coal beds as much as 2.5 ft thick are intermittently exposed in the Cockpict Country between Wait-a-bit

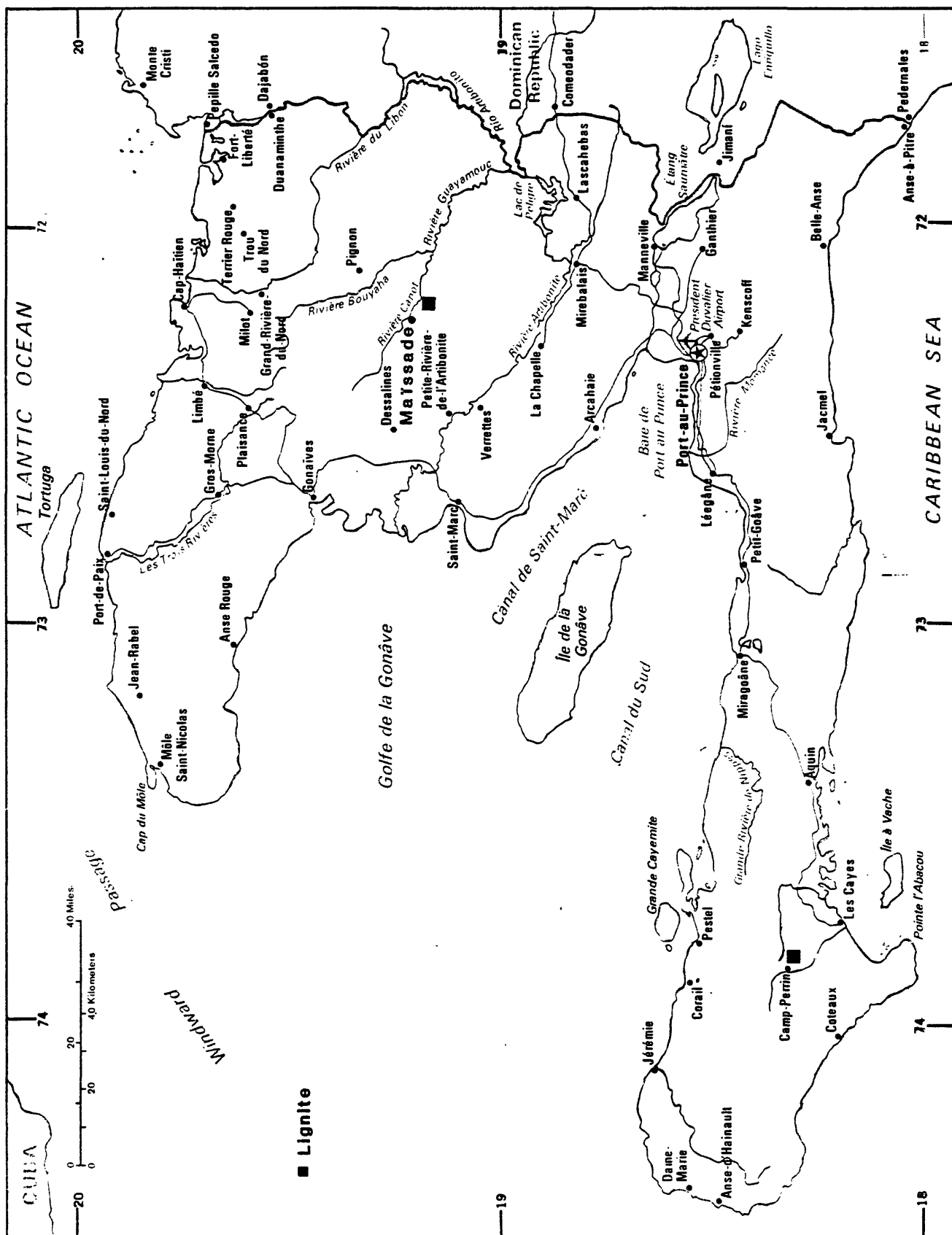


Figure 12. Lignite localities in Haiti

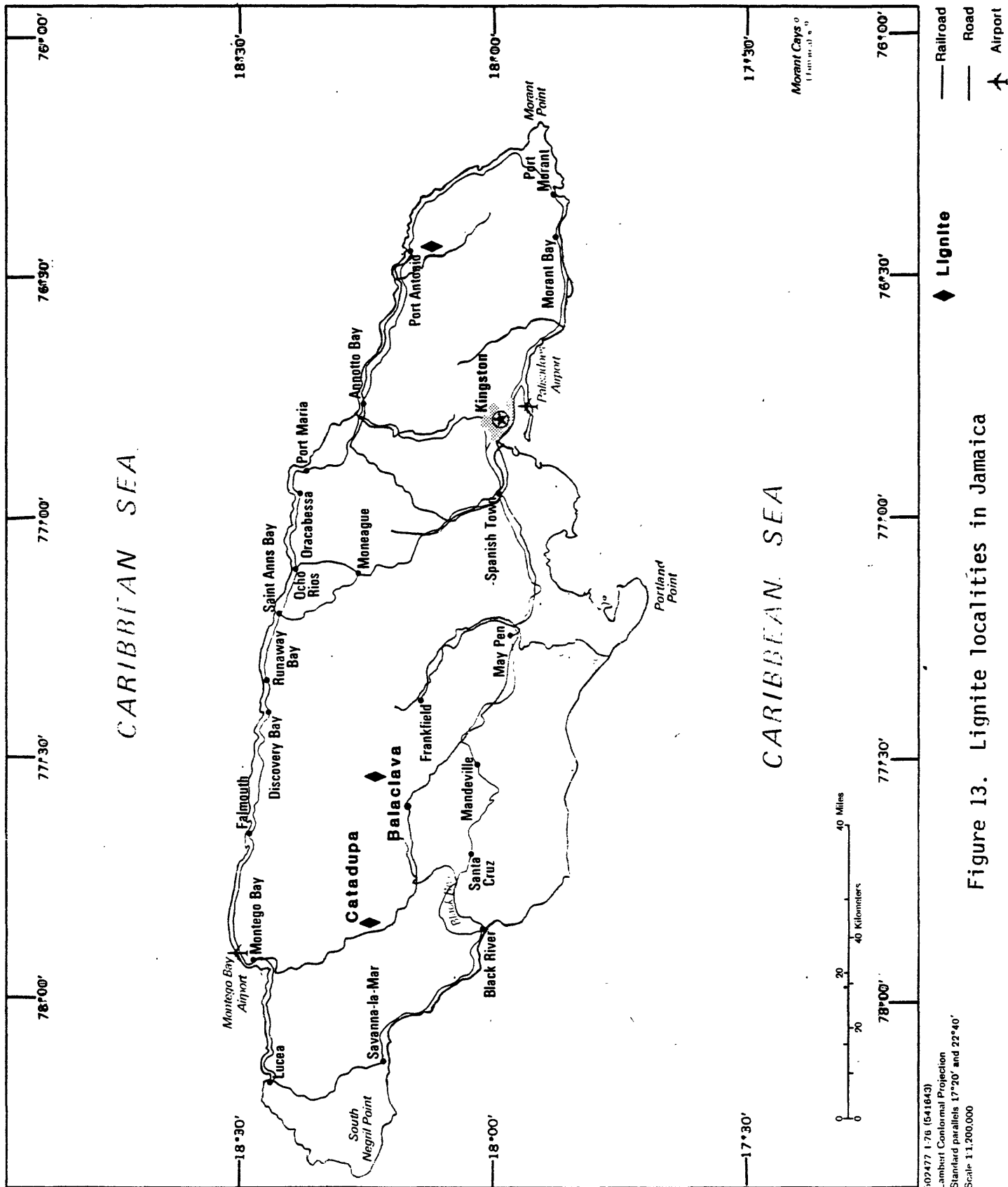


Figure 13. Lignite localities in Jamaica

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 Lambert Conformal Projection
 Standard parallels 17°20' and 22°40'
 Scale 1:1,200,000

and Catadupa. Some lignite samples collected from the Yellow Limestone contain 33 percent volatiles, 24 percent fixed carbon, and 30 percent ash; most of the coal-bearing material throughout the districts of St. James, St. Elizabeth, and Trelawny (west-central Jamaica) however, is lignitic clay and has as much as 70 percent ash.

Griener, H. R., 1965, Oil and gas potential of Jamaica: Jamaica Geological Survey, Bulletin 5.

Thin layers of lignite, tar sands, and bituminous shale and limestone were penetrated at depths between 1378 and 1468 ft in drill-holes near Jamaica's southern coast in Manchester district south of Manderville. Two horizons showed traces of bituminous content. These findings were in the Yellow Limestone and contemporaneous shale and sandstone of middle Eocene age and in certain upper Cretaceous limestone.

Lignite in Nicaragua

Kottlowski, F. E., Cross, A. T., and Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 68.

Coal in Nicaragua is lignite of latest Tertiary age. Coal beds in the department of Chinandega (fig. 14) are at Los Mercedes, Providencia, and San Luis. Reports of lignite in the department of Leon are at Margarita, Providencia, Soledad, and Paula. In the department of Esteli, lignite has been identified in the region around the city of Esteli. In the department of Madriz, lignite is exposed in the valley between Pueblo Nuevo and Somoto. Also, lignite crops out in the department of Chontales at Rio Mico.

Lignite in Panama

Kottlowski, F. E., Cross, A. T., Meyerhoff, A. A., 1978, Coal resources of the Americas: GSA Special Paper 179, p. 67.

Lignite in Panama is of Cenozoic age; beds have been found in 5 provinces.

In the Bocos de Toro Province, lignite beds are in the Gatun Formation of Miocene age on the islands of Laguna de Chiriqui (fig. 15). Lignite in the province of

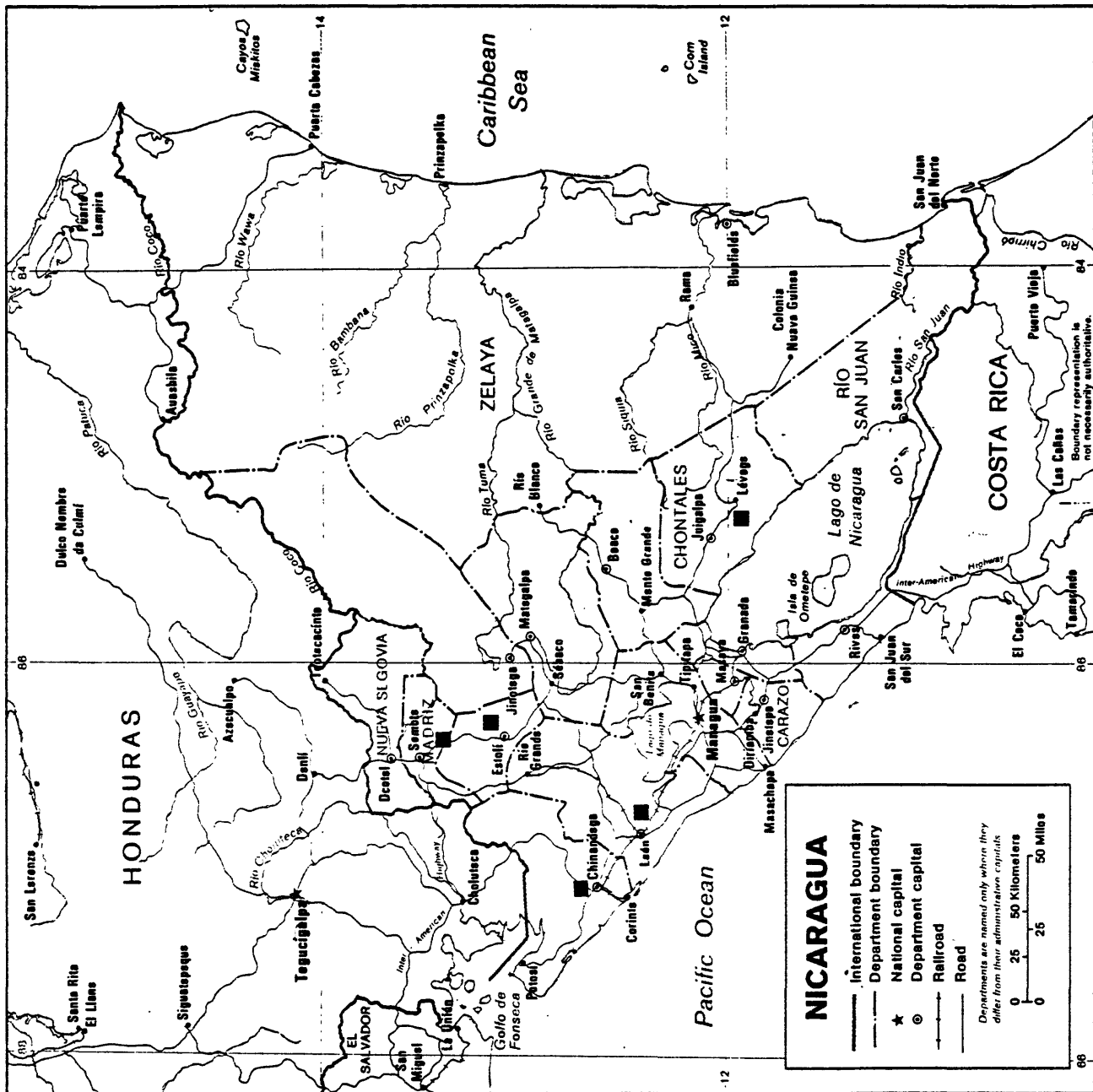
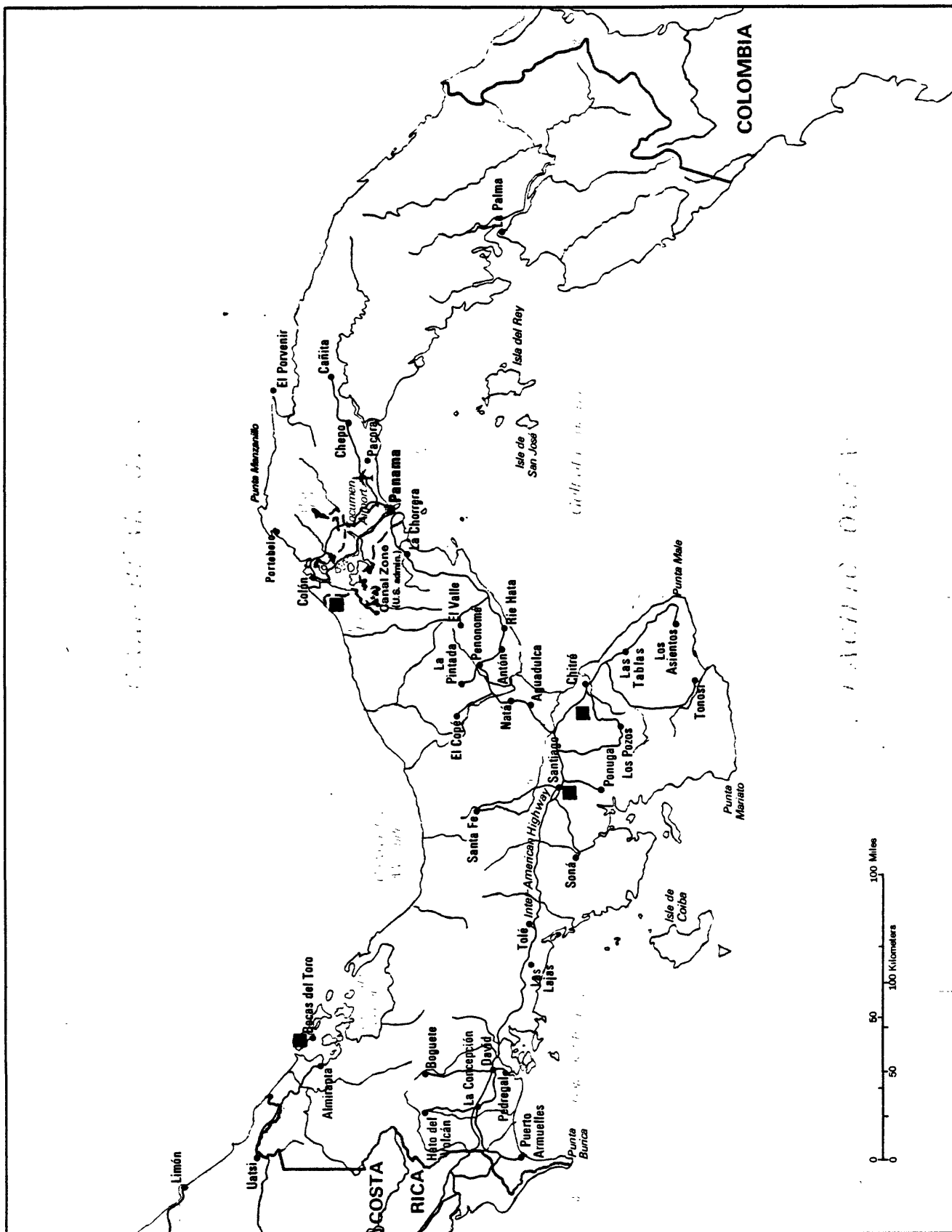


Figure 14. Lignite localities in Nicaragua.



502480 1:76 (641409)
 Lambert Conformal Projection
 Standard parallels 9°20' and 14°10'
 Scale 1:3,200,000

Figure 15. Lignite localities in Panama.

Veraguas is known near La Mesa and Santiago. Lignite beds in Oligocene and Miocene sediments are near Parita in the Herrera Province. Also, lignite beds occur near Bombacho in the province of Los Santos and at Rio Indio in the province of Colon.

Terry, R. A., 1956, A. Geological reconnaissance of Panama: California Academy of Science, Occasional Paper no. XXIII, p. 86.

Coal and lignite has been known for a century in middle Miocene beds on the islands and shores of Chiriqui Lagoon and on the upper Changuinola River in the province of Bocos de Toro. In central Panama, lignite is identified in late Oligocene and early Miocene beds at La Mesa, Santiago, Parita, and Marcaracas in the provinces of Veraguas, Herrera, and Los Santos, south of Capira in the Panama Province, and at Rio Indio, just west of the canal zone in the province of Colon.

Lignite in Puerto Rico

Beinroth, F. H., 1969, An outline of the geology of Puerto Rico: Puerto Rico Agricultural Experiment Station Bulletin 213, P.25.

Thin beds of lignite of little commercial value are known in the Moca-San Sebastian-Lares district (fig. 16). The lignite is in the San Sebastian Clay. No other coal beds have been found in Puerto Rico.

Bureau of Mines, 1941, Report of the Bureau of Mines on the mineral resources of Puerto Rico: Bureau of Mines, p. 51.

Beds of lignite in carbonaceous shale are known at present in Corozol in the east and at Moca in the west. The lignite is of little commercial value. The thickest bed is 6 inches thick and the average seam is 1 to 2 inches thick. Analyzed samples of the lignite show high ash and sulfur contents.

Hill, R. T., 1899, The mineral resources of Puerto Rico: U.S. Geological Survey Extract from the 20th annual report, p. 7.

A lignite deposit near Moca on the western part of the island may be worthy of development. Another lignite bed is in a bituminous clay formation near San

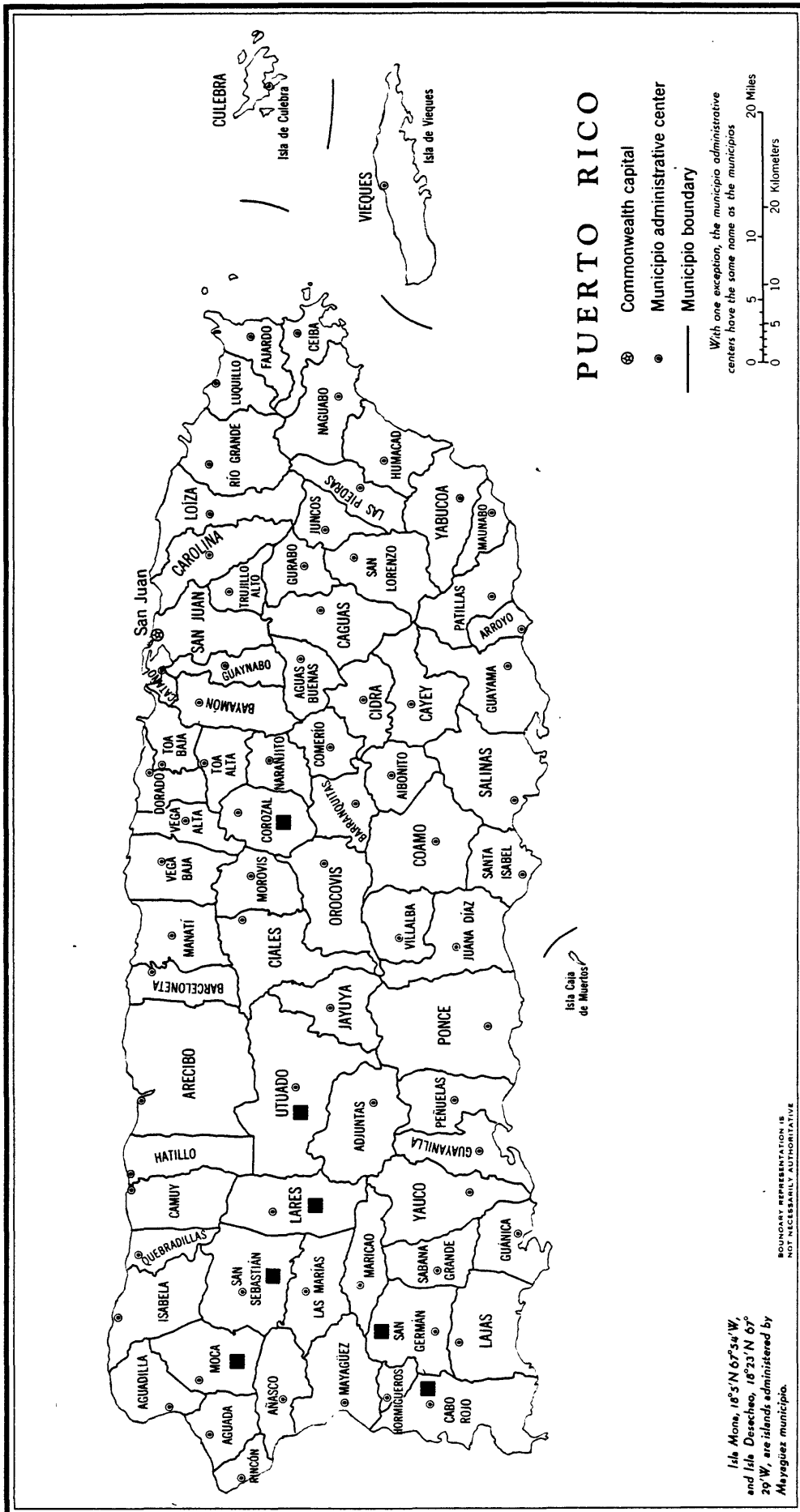


Figure 16. Lignite localities in Puerto Rico.

Sebastian, also in the western part of the island.

Nitze, H. B. C., 1899, Some of the mineral resources of Puerto Rico: U.S. Geological Survey Extract for the 20th annual report, p. 787.

Low quality lignite beds containing iron pyrites are in western Puerto Rico. Some locations of lignite occurrences are near Utuado, Moca, Lares, San Sebastian, San German, and Coba-Rojo. Peat is known in the marshy region along the north coast.

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